

Applied Mathematics and Artificial Intelligence: Second-round Sample Tasks for the Open Doors Bachelor's Track

This sample test comprises 36 tasks, including: 22 entry-level tasks, each correct answer assigned 1 point; 11 intermediate-level tasks, each correct answer assigned 4 points; 3 advanced-level tasks requiring a detailed answer, each correct answer assigned 11 or 12 points.

For advanced-level tasks requiring a detailed answer, assessment criteria, and a standard answer are provided.

Field of Science 1. Mathematical Logic

Task 1

Entry level (1 point)

Which statement is logically equivalent to the statement $\overline{A \Rightarrow (B \vee C)}$?

- a) $A \wedge \overline{B} \wedge \overline{C}$
- b) $\overline{A} \wedge \overline{B} \wedge \overline{C}$
- c) $A \wedge (\overline{B} \vee \overline{C})$
- d) $\overline{A} \wedge (B \vee C)$

Answer: a

Task 2

Entry level (1 point)

Tanya is younger than Vika but older than Sonya. Katya is older than Tanya but younger than Vika. Anya is older than Tanya but younger than Vika. Two of these girls are the same age. Name the girls who are the same age, as well as the youngest and the oldest.

- a) Tanya and Anya are the same age. The youngest is Katya, and the oldest is Vika.
- b) **Katya and Anya are the same age. The youngest is Sonya, and the oldest is Vika.**
- c) Sonya and Anya are the same age. The youngest is Katya, and the oldest is Vika.
- d) Katya and Anya are the same age. The youngest is Tanya, and the oldest is Vika.

Answer: b

Task 3

Entry level (1 point)

Identify the equation that has no solutions:

- a) $x^2 - 5x - 7 = 0$
- b) $3^x = \sqrt{2} - 2$
- c) $\log_2(2x + 3) = -\pi$
- d) $\cos x = 0.7$

Answer: b

Task 4
Advanced level (12 points)

For the purposes of this task, all five-digit natural numbers written in decimal notation are considered.

1. How many five-digit natural numbers contain only distinct odd digits?
2. How many five-digit natural numbers contain only odd digits?
3. Find the sum of all five-digit natural numbers composed of odd digits.
4. Find the probability that a randomly selected five-digit natural number contains only odd digits.

Note: A complete solution must include your method and reasoning. Providing the final answer alone will not suffice.

Solution:

1. There are five odd digits in total: 1, 3, 5, 7, and 9. Therefore, the number of five-digit natural numbers that contain only distinct odd digits is equal to the number of permutations of these 5 digits without repetition. This number is $5! = 120$.

2. The number of five-digit numbers composed only of odd digits corresponds to the number of 5-permutations with repetition of 5 elements. This number is $5^5 = 3125$.

3. First method. Consider all five-digit odd numbers and first find the sum of digits that are in the units place. Each odd digit appears in the units place as many times as there are four-digit numbers composed only of odd digits, that is, $5^4 = 625$ times. Therefore, the sum of the digits in the units place of all five-digit numbers made up of odd digits equals $625 \times (1 + 3 + 5 + 7 + 9) = 625 \times 25 = 15,625$. By the same logic, the sum of the digits in the tens, hundreds, thousands, and ten-thousands places is also 15,625 each. Thus, the sum of all five-digit numbers composed of odd digits equals $15,625 \times (1 + 10 + 100 + 1,000 + 10,000) = 15,625 \times 11,111 = 173,609,375$.

2nd method. Pairs of odd digits 3 and 7, 1 and 9 are symmetrical with respect to the number 5. Consider a five-digit number composed of odd digits $\overline{a_4 a_3 a_2 a_1 a_0} = a_4 \cdot 10^4 + a_3 \cdot 10^3 + a_2 \cdot 10^2 + a_1 \cdot 10 + a_0$, where a_0, a_1, a_2, a_3 , and a_4 are odd digits. Then, for $i = 0, 1, 2, 3, 4$, the digit $10 - a_i$ is odd. If the given number is not equal to 55,555, then the number $\overline{(10 - a_4)(10 - a_3)(10 - a_2)(10 - a_1)(10 - a_0)} = (10 - a_4) \cdot 10^4 + (10 - a_3) \cdot 10^3 + (10 - a_2) \cdot 10^2 + (10 - a_1) \cdot 10 + (10 - a_0)$ is composed of odd digits and symmetrical to the number $\overline{a_4 a_3 a_2 a_1 a_0}$ relative to 55,555. Therefore, all five-digit numbers made up of odd digits can be divided into pairs that are symmetrical relative to the number 55,555 (there will be no pair for the number 55,555). The number of five-digit numbers whose notation contains only odd digits is 3125 (see the solution to point 2). Therefore, pairs of numbers symmetrical with respect to 55,555 is $(3125 - 1)/2 = 1562$. The sum of the numbers in each pair is equal to $\overline{(10 - a_4)(10 - a_3)(10 - a_2)(10 - a_1)(10 - a_0)} + \overline{a_4 a_3 a_2 a_1 a_0} = 10 \cdot 10^4 + 10 \cdot 10^3 + 10 \cdot 10^2 + 10 \cdot 10 + 10 = 111,110$. Then, the sum of all five-digit numbers made up of odd digits is $1562 \times 111,110 + 55,555 = 173,609,375$.

4. The total number of five-digit numbers is $99,999 - 9,999 = 90,000$, and the number of five-digit numbers containing only odd digits is 3125 (see the solution to point 2). Therefore, the probability that a randomly selected five-digit number will contain only odd digits is $\frac{3125}{90000} = \frac{5}{144}$.

Answer: 1) 120; 2) 3125; 3) 173 609 375; 4) $\frac{5}{144}$

Assessment criteria

Question number	Criterion	Points
1	The number of five-digit natural numbers whose notation contains only distinct odd digits was correctly and justifiably determined.	2
	An incorrect answer to the first question was obtained due to a computational error, although it was correctly stated that the task involves finding the number of permutations without repetitions of five elements.	1
	The solution to the first part of the problem does not meet any of the listed criteria	0
2	The number of five-digit natural numbers containing only odd digits was correctly and justifiably determined.	3
	An incorrect answer was given to the second question due to a computational error; however, it was correctly noted that the task requires finding the number of 5-element arrangements with repetition from a set of 5.	1
	The solution to the second part of the problem does not meet any of the listed criteria	0
3	The sum of all five-digit natural numbers composed of odd digits was correctly and justifiably determined.	5
	An incorrect answer was given to the third part of the problem due to a computational error.	3
	The correct answer to the third part of the problem was provided, but the justification for the method used is missing—specifically, why each odd digit appears 625 times in each place (first method), why all numbers except one can be paired to have equal sums (second method), or a similar oversight is present.	2
	The amount was not found, but the solution demonstrates the correct approach to calculating it (using the algorithm specified in the solution, the correct value can be determined).	1
	The solution to the third part of the problem does not meet any of the listed criteria.	0
4	The correct answer to the fourth question of the problem was correctly and justifiably obtained.	2
	An incorrect answer was given to the fourth question due to a computational error; however, it was indicated that the probability can be found using the classical definition of probability, and both the total number of five-digit natural numbers and the number of five-digit natural numbers composed of odd digits were correctly determined.	1
	The solution to the fourth part of the problem does not meet any of the listed criteria	0
Maximum score awarded for the task		12

Field of Science 2. Mathematics

Task 5
Entry level (1 point)

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Solve the inequality $\frac{x^2+5x+6}{x^2+3x+2} < 0$

- a) $(-3; -2) \cup (-2; -1)$
- b) $(-\infty; -3) \cup (-2; -1)$
- c) $(-3; -1)$
- d) $(-\infty; -3) \cup (-1; +\infty)$

Answer: a

Task 6
Entry level (1 point)

Find the smallest positive root of the equation $\sin(\pi x) = \frac{1}{2}$

- a) $\frac{5}{6}$
- b) $\frac{1}{6}$
- c) $\frac{\pi}{6}$
- d) $\frac{1}{2}$

Answer: b

Task 7
Intermediate level (4 points)

Find the value of the expression $\frac{\cos 2x}{\sin x \cdot \cos x + \sin^2 x} - \cot x$

Answer: -1

Task 8
Intermediate level (4 points)

Find the integer solution to the inequality $\log_{\frac{2}{3}}\left(x^2 - \frac{11x}{2} + \frac{15}{2}\right) > -1$.

Answer: 2

Field of Science 3. Mathematical Physics

Task 9
Entry level (1 point)

The distance s (in meters) to a lightning strike can be approximated using the formula $s = 330t$, where t is the number of seconds between the flash and the thunder. Determine the distance to the lightning strike if $t = 14$ s. Give your answer in kilometers, rounded to the nearest whole number.

- 4
a) 46
b) 5
c) 4620

Answer: c

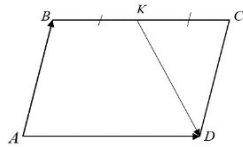
Task 10
Entry level (1 point)

Find the ordinate of the intersection point of graphs representing the functions $y = 2x - 3$ and $y = -2x + 5$.

- a) 2
b) 1
c) 0.5
d) -2

Answer: b

Task 11
Entry level (1 point)

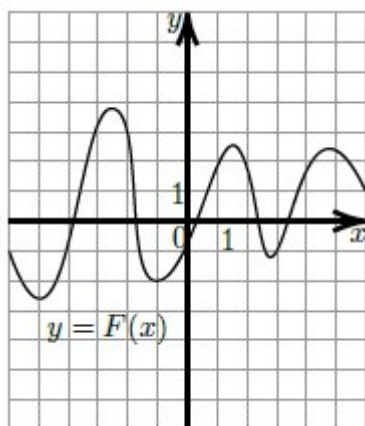


In parallelogram $ABCD$, point K is the midpoint of side BC . Express the vector \overrightarrow{KD} in terms of the vectors \overrightarrow{AB} and \overrightarrow{AD} .

- a) $\overrightarrow{KD} = \frac{1}{2}\overrightarrow{AB} - \overrightarrow{AD}$
b) $\overrightarrow{KD} = \frac{1}{2}\overrightarrow{AD} - \overrightarrow{AB}$
c) $\overrightarrow{KD} = \overrightarrow{AD} - \overrightarrow{AB}$
d) $\overrightarrow{KD} = \frac{1}{2}\overrightarrow{AD} + \overrightarrow{AB}$

Answer: b

Task 12
Intermediate level (4 points)



The figure shows the graph of a function $y = F(x)$, one of the antiderivatives $f(x)$ defined on the interval $[-6, 6]$. Find the number of solutions to the equation $f(x) = 0$ on the interval $(-3, 3)$.

Answer: 4

Field of Science 4. Applied Mathematics

Task 13 Entry level (1 point)

If the trousers cost 30% more than the shirt and 22% less than the jacket, by what percentage is the shirt less expensive than the jacket?

- a) 52%
- b) 8%
- c) **40%**
- d) 26%

Answer: Answer c

Task 14 Entry level (1 point)

Find the maximum point of the function $y = \sqrt{4x - x^2} - 3$.

- a) 1
- b) **2**
- c) -2
- d) 4

Answer: Answer b

Task 15 Intermediate level (4 points)

The legs of a right triangle are 3 and 4. Find the radius of the circle inscribed in this triangle.

Answer: 1

Task 16 Advanced level (11 points)

A right triangle is given, with the lengths of its legs expressed in irrational numbers.

1. Can the area of such a triangle be a rational number?
2. Can both the area and perimeter of such a triangle be rational numbers?
3. Can the area, the sum of the legs' lengths, and the length of the bisector drawn from the right angle vertex of such a triangle all be rational numbers?

Note: A complete solution must include your method and reasoning. Providing the final answer alone will not suffice.

Solution

Let a and b be the lengths of the legs, c the length of the hypotenuse, S the area of the triangle, P the triangle perimeter, and l the length of the bisector drawn from the vertex of a right angle.

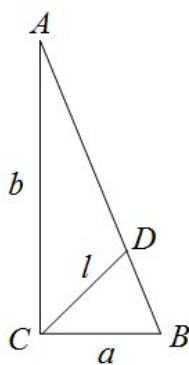
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1. Yes, it can. To illustrate, let $a = \sqrt{2}$, $b = 2\sqrt{2}$, a, b be irrational numbers. Then, $S = \frac{1}{2}ab = \frac{1}{2} \cdot \sqrt{2} \cdot 2\sqrt{2} = 2$ is a rational number.

2. Yes, they can. Suppose that $a = 5 - \sqrt{7}$, $b = 5 + \sqrt{7}$, a, b are irrational numbers. Then, $S = \frac{1}{2}ab = \frac{1}{2} \cdot (5 - \sqrt{7}) \cdot (5 + \sqrt{7}) = 9$ is a rational number. According to the Pythagorean theorem $c = \sqrt{a^2 + b^2} = \sqrt{(5 - \sqrt{7})^2 + (5 + \sqrt{7})^2} = \sqrt{2 \cdot (25 + 7)} = 8$, $P = a + b + c = (5 - \sqrt{7}) + (5 + \sqrt{7}) + 8 = 18$ is a rational number.

3. No, they cannot. Assume, for the sake of contradiction, that irrational numbers a and b exist such that S , $a + b$, and l are rational numbers. Consider $\triangle ABC$ with right angle C , $AC = b$, $CB = a$. Let us draw the bisector CD , $CD = l$. $S = \frac{1}{2}ab$ is assumed to be rational. Yet, $S = S_{ACD} + S_{BCD}$. $\angle ACD = \angle BCD = 45^\circ$, since CD is the bisector of the right angle $S_{ACD} = \frac{1}{2}AC \cdot CD \cdot \sin \angle ACD$, $S_{BCD} = \frac{1}{2}BC \cdot CD \cdot \sin \angle BCD$. Then, $S = \frac{1}{2}a \sin 45^\circ + \frac{1}{2}b \sin 45^\circ = \frac{1}{2}l(a + b) \sin 45^\circ = \frac{1}{4}l(a + b) \cdot \sqrt{2}$. The equality $S = \frac{1}{4}l(a + b) \cdot \sqrt{2}$ is impossible since S is assumed to be a rational number, and $\frac{1}{4}l(a + b) \cdot \sqrt{2}$ is an irrational number as it is the product of the rational number $\frac{1}{4}l(a + b)$ ($a + b$ and l are assumed to be rational numbers) and the irrational number $\sqrt{2}$.



Answer: 1. Yes, it can. 2. Yes, they can. 3. No, they cannot.

Assessment criteria

Question number	Criterion	Points
1	An example of a right triangle that satisfies the conditions of the problem was given, and it was shown that its area is a rational number.	3
	An example of a right triangle that satisfies the conditions of the problem was given, and it was shown that its area is a rational number, but a computational error was made.	2
	An example of a right triangle that satisfies the conditions of the problem was given, but it was not shown that its area is a rational number.	1
	The solution to the first part of the problem does not meet any of the listed criteria	0
2	An example of a right triangle that satisfies the conditions of the problem is given, and it is shown that its area and perimeter are rational numbers.	4
	An example of a right triangle that satisfies the conditions of the problem was given, and it was shown that its area and perimeter are rational numbers, but a computational error was made.	2
	An example of a right triangle that satisfies the conditions of the problem is given, but it is not shown that its area and perimeter are rational numbers.	1
	The solution to the second part of the problem does not meet any of the listed criteria	0
3	It was proven that no right triangle with irrational legs satisfies the	4

	conditions of the third part of the problem.	
	It is proven that no right triangle with irrational legs satisfies the conditions of the third part of the problem, but a computational error was made during the proof that does not affect the logic of the reasoning.	3
	When proving that no right triangle with irrational legs satisfies the conditions of the third part of the problem, one of the less important steps was missed.	2
	When proving that no right triangle with irrational legs satisfies the conditions of the third question of the problem, one essential step was missed.	1
	The solution to the third part of the problem does not meet any of the listed criteria	0
Maximum score awarded for the task		11

Field of Science 5. Statistics and Probability

Task 17 Entry level (1 point)

Find the value of p , given that a discrete random variable is defined by the following probability distribution table:

x_i	1	3	7	8
p_i	0.1	0.4	p	0.15

- a) 0.7
- b) 0.25
- c) 0.3
- d) **0.35**

Answer: d

Task 18 Entry level (1 point)

Four textbooks on probability theory and three textbooks on geometry are randomly arranged on a bookshelf. What is the probability that all books on the same subject are grouped together?

- a) $\frac{2}{35}$
- b) $\frac{1}{35}$
- c) $\frac{4}{7}$
- d) $\frac{3}{7}$

Answer: a

Task 19 Intermediate level (4 points)

A store serves coffee using two identical vending machines. The probability that a machine runs out of coffee by the end of the day is 0.25, and the probability that both machines run out is 0.15. Find the probability that both machines still have coffee at the end of the day.

Answer: 0.65

Task 20
Intermediate level (4 points)

The device consists of six elements connected in parallel, each operating independently. The probability that any given element functions without failure during time t is 0.6. The device operates without failure if at least one element functions. What is the probability that the device operates without failure during time t ? Round your answer to the nearest thousandth.

Answer: 0.996

Field of Science 6. Information Systems

Task 21
Entry level (1 point)

Convert 512 bits into an appropriate unit of measurement.

- a) 0.5 kilobytes;
- b) **64 bytes;**
- c) 256 bytes;
- d) 50 bytes.

Answer: b

Task 22
Entry level (1 point)

What is the smallest integer value of X for which the following expression holds true?
 $(-2 \leq X + 5 < 7) \wedge \neg(X \cdot X \geq 49)$

- a) -7
- b) **-6**
- c) 1
- d) 2

Answer: b

Task 23
Intermediate level (4 points)

Among the numbers 100_{10} , 90_{10} , and 80_{10} , find the one whose binary representation contains the fewest ones. In your answer, indicate how many ones appear in its binary representation.

Answer: 2

Task 24
Intermediate level (4 points)

The algorithm for calculating the value of a function $F(n)$, where n is a natural number, is given by the following equations:

$$F(n) = n, \text{ for } n < 11;$$

$$F(n) = n + F(n - 1), \text{ if } n \geq 11.$$

What is the value of the expression $F(2024) - F(2021)$?

Answer: 6069

Field of Science 7. Artificial Intelligence

Task 25
Entry level (1 point)

Which of the following is the definition of artificial intelligence?

- a) A cybernetic system—part human, part machine—comprising a hyperalloy combat chassis, governed by a microprocessor; its internal structure is fully armored and exceptionally strong; encasing it is living human tissue—flesh, skin, hair, and blood—engineered specifically for cyborg usage.
- b) Artificial neural network capable of learning and self-improving.
- c) **Software alone, or combined with hardware, that simulates human cognitive abilities.**
- d) A program capable of self-awareness and independent thinking.

Answer: c

Task 26
Entry level (1 point)

In one of the Unicode encodings, each character is represented using 16 bits. Find the size in bytes of the following sentence in this encoding:

Rumours about me will spread all over Great Russia.

- a) **102**
- b) 672
- c) 51
- d) 84

Answer: a

Task 27
Intermediate level (4 points)

In the query language of a search engine, the symbol “|” represents the logical operation “OR,” and the symbol “&” represents the logical operation “AND.” The table shows queries and the number of pages found for a specific segment of the Internet.

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Request	Pages found (in thousands)
Battleship Corvette	3320
Battleship & Corvette	1300
Battleship	2100

How many pages (in thousands) are found for the query “Corvette”?

Assume all queries were executed almost simultaneously, so the set of pages containing all the searched words remained unchanged during the execution of the queries.

Answer: 2520

Task 28 Advanced level (11 points)

Each vertex in a tree has a degree of either 1 or 4. There are 50 vertices of degree 4. Each of these is connected to either two or three vertices of degree 1. A vertex of degree 4 connected to two vertices of degree 1 is called strong, while one connected to three vertices of degree 1 is called weak.

1. How many vertices are there in such a tree?
2. Find the number of weak vertices in the tree.
3. Determine the length of the shortest path between two weak vertices, assuming each edge has a length of 1.

Note: A complete solution must include your method and reasoning. Providing the final answer alone will not suffice.

Solution:

1. Let n be the number of vertices in the tree and m the number of edges. According to the handshaking lemma, the sum of the degrees of all vertices in a graph is equal to $2m$. In this tree, there are 50 vertices of degree 4 and $n-50$ vertices of degree 1. Thus, the sum of all degrees is $4 \cdot 50 + 1 \cdot (n-50) = n + 150$. Therefore,

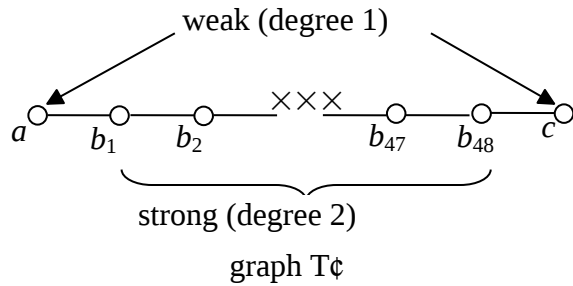
$$n + 150 = 2m \quad (1)$$

In any tree $m = n - 1$. Substituting this into equation (1) gives $n + 150 = 2n - 2$, which yields $n = 152$.

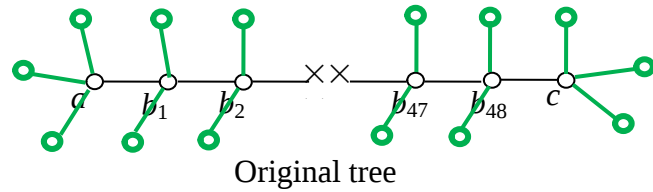
2. If all vertices of degree 1 are removed from the tree, the resulting graph T' is also a tree with 50 vertices and 49 edges. Each strong vertex has 2 neighbors removed, so its degree in T' is 2. Each weak vertex has 3 neighbors removed, reducing its degree to 1.

3. Let the number of weak vertices be x . Then, the number of strong vertices is $50-x$, and the sum of all degrees in the tree T' is $2(50-x) + x = 100-x$. Since this sum equals twice the number of vertices, $100-x = 2 \cdot 49 = 98$, which gives $x = 2$.

4. Consider the tree T' from point 2. Two of its vertices are weak and have degree 1, so the shortest path between them needs to be found. The remaining vertices have degree 2. Take one of the degree-1 vertices and denote it as a . Let it be connected by an edge to vertex b_1 . We claim that b_1 has degree 2. Indeed, if b_1 had degree 1, then no other vertex would be adjacent to either a or b_1 , rendering the graph disconnected—which contradicts the definition of a tree. Thus, b_1 has degree 2. Let b_2 be the neighbor of b_1 different from a . By similar reasoning, b_2 also has degree 2. Then, we find that b_2 is adjacent to b_3 of degree 2, b_3 is adjacent to b_4 of degree 2, and so on, until b_{47} is adjacent to b_{48} , also of degree 2. Since T' contains no other vertices of degree 2, the second neighbor of b_{48} must be the other vertex of degree 1, which we denote as c .



So, the tree T' is a chain from a to c , passing sequentially through b_1, b_2, \dots, b_{48} . The only (and therefore the shortest) path between a and c consists of edges $(a, b_1), (b_1, b_2), \dots, (b_{47}, b_{48}), (b_{48}, c)$ and thus has length 49.



Answer: 1) 152; 2) 2; 3) 49

Assessment criteria

Question number	Criterion	points
1	The number of vertices in the given tree was correctly and justifiably determined.	3
	An incorrect answer to the first question of the problem was given due to a computational error, but it was noted that the number of edges in a tree is one fewer than the number of vertices, and the handshaking lemma was cited.	2
	The handshaking lemma was mentioned, but no further progress was made, or an example of a tree with the specified characteristics was constructed and the number of vertices counted correctly, while the tree's structure was determined incorrectly or without justification of its uniqueness.	1
	The solution to the first part of the problem does not meet any of the listed criteria	0
2	The number of weak vertices of a given tree was correctly and justifiably determined.	4
	An incorrect answer was given to the second question of the problem due to a computational error, but the solution has included the idea of considering a tree obtained from the original by removing vertices of degree 1.	2
	A correct example of a tree with the specified characteristics was constructed and the number of weak vertices in it was correctly calculated, but there is no justification that the structure of the tree is the only possible one.	1
	The solution to the second question does not meet any of the listed	0

	criteria.	
3	The distance between the weak vertices of this graph was correctly and justifiably determined.	4
	An incorrect answer was given to the third question of the problem, but it was correctly demonstrated that the tree T' is a chain with weak vertices at its ends.	2
	An example of a tree with the specified characteristics was constructed and the distance between the weak vertices calculated correctly, but no justification was provided that the tree's structure is the only possible one	1
	The solution to the third question does not meet any of the listed criteria.	0
Maximum score awarded for the task		11

Field of Science 8. Cybernetics

Task 29 Entry level (1 point)

What number should replace the asterisk in the equation $19_{16} \cdot 100_2 + 1 * 1_8 = 197_{10}$?

- a) 2
- b) 4
- c) 0
- d) 6

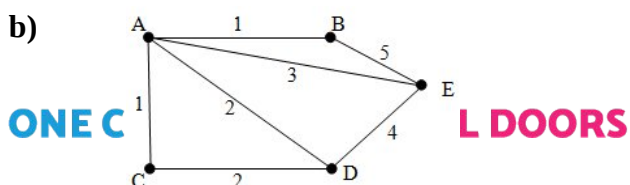
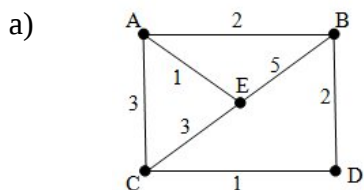
Answer: b

Task 30 Entry level (1 point)

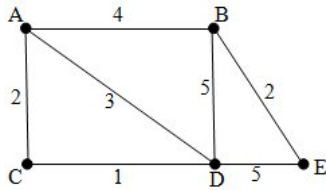
The table shows the transportation costs between five railroad stations, labeled A, B, C, D, and E.

	A	B	C	D	E
A		1	1	2	3
B	1				5
C	1			2	
D	2		2		4
E	3	5		4	

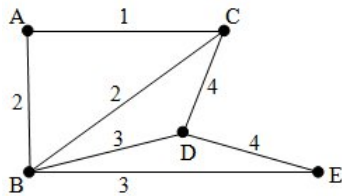
Identify the graph that matches the table.



c)



d)

**Answer: b**

Task 31

Entry level (1 point)

A program fragment is provided that processes an array A containing 10 elements.

BASIC

```

j = 1
FOR i = 1 TO 10
  IF A(i) = A(j) THEN
    j = i
  ENDIF
NEXT i
s = j

```

Algorithmic language

```

j := 1
begin cycle for i from 1 to 10
  if A[i] = A[j] then
    j := i
  end if
End cycle
s := j

```

```

j = 1;
for ( i = 1; i <= 10; i ++ )
  if (A[i] == A[j])
  {
    j = i;
  }
s = j;

```

Python

```

j = 1
for i in range(1, 11):
    if A[i] == A[j]:
        j = i
s = j

```

Pascal

```

j := 1;
for i := 1 to 10 do
  if A[i] = A[j] then j := i;
s := j;

```

C++

```

j = 1;
for ( i = 1; i <= 10; i ++ )
  if (A[i] == A[j])
  {
    j = i;
  }
s = j;

```

What will the value of the variable s be after executing this algorithm?

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- a) The value of the variable s is 1.
- b) The value of the variable s is 10.
- c) **The value of the variable s is equal to the index of the element that is equal to the first element and has the highest index.**
- d) The value of the variable s is equal to the index of the element that is equal to the last element and has the lowest index.

Answer: c

Task 32
Intermediate level (4 points)

The Gamma executor has two teams, which are assigned numbers:

1. add 3;

2. multiply by b

(b is an unknown natural number; $b \geq 2$).

Executing the first command increases the number on the screen by 3, while executing the second command multiplies the number by b . The program for the Gamma executor is a sequence of command numbers. It is known that the program 11211 transforms the number 1 into 97. Determine the value of b .

Answer: 13

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Task 33
Entry level (1 point)

Arkady, Boris, Vladimir, Grigory, and Dmitry each shook hands with every other person once. How many handshakes took place?

- a) 5
- b) 6
- c) 8
- d) 9
- e) **10**

Answer: e

Task 34
Entry level (1 point)

An article typed on a computer contains 20 pages, each with 40 lines, and each line with 48 characters. In one Unicode representation, each character is encoded using two bytes. Determine the size of the article in kilobytes in this Unicode format.

- a) 76800
- b) 76.8
- c) **37.5**

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d) 75

Answer: d

Task 35
Entry level (1 point)

Logical expression value: $(A \cup \emptyset A) \cup (A \cup A)$. Given that A is TRUE, what is the value of the expression?

- a) **TRUE**
- b) FALSE
- c) 0
- d) Insufficient information

Answer: a

Task 36
Intermediate level (4 points)

The executor, The Editor, receives a string of digits as input and converts it. The Editor can perform two commands, where v and w denote strings of digits.

A) `replace(v, w)`

This command replaces the first leftmost occurrence of the string v in the line with the string w . For example, executing the command **`replace(111, 27)`** converts the string 05111150 into 0527150.

If v does not occur in the string, executing **`replace(v, w)`** leaves the string unchanged.

B) `found(v)`

This command checks whether the string v appears in the line. If it does, the command returns the boolean value **true**; otherwise, it returns **false**. The line itself remains unchanged.

Cycle

WHILE condition

sequence of commands

END WHILE

is executed as long as the condition is true.

What string will be produced by applying the following program to a string of 98 ones?

START

WHILE found(1111)

replace(1111, 22)

replace(222, 1)

END WHILE

END

Answer: 12

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